

CLAIMS

We claim:

1 1. A micropump, comprising:
2 a pumping chamber, wherein said pumping chamber includes an inlet for drawing
3 fluid therein and an outlet for expelling said fluid out of said chamber, and
4 structure for mechanically urging said fluid from said inlet to said outlet, wherein
5 said micropump is fully monolithic forming a monolithic body, said pump having a total
6 thickness of no more than about 12 microns.

1 2. The micropump of claim 1, wherein said pumping chamber includes at least
2 one rotatable disc in fluid communication with said fluid, said structure for mechanically
3 urging comprising said rotatable disc.

1 3. The micropump of claim 2, wherein the at least one rotatable disc comprises at
2 least one protrusion extending from the disc.

1 4. The micropump of claim 3, wherein the at least one protrusion forms a spiral
2 shaped fluid pathway concentric with the at least one rotatable disc.

1 5. The micropump of claim 3, wherein the at least one protrusion forms a
2 plurality of radial vanes extending from an axis of rotation of the rotatable disc.

1 6. The micropump of claim 2, wherein at least one rotatable disc further
2 comprises a plurality of gear teeth on a side surface of the rotatable disc.

1 7. The micropump of claim 6, further comprising at least one crescent shaped
2 diverter positioned in the pumping chamber proximate to the at least one rotatable disc, and
3 wherein an inner surface of the monolithic body includes a plurality of gear teeth for
4 meshing with the at least one rotatable disc.

1 8. The micropump of claim 2, further comprising at least one cap forming a
2 portion of the monolithic body and having an opening enabling a driving gear to contact the
3 at least one rotatable disc contained in the monolithic body.

1 9. The micropump of claim 2, further comprising a labyrinth seal formed from a
2 first protrusion forming a ring extending generally vertically from a base layer and
3 surrounding the rotatable disc, a second protrusion forming a ring extending generally
4 vertically from the base layer and positioned inside the first protrusion, and a third protrusion
5 forming a ring extending generally vertically from the at least one rotatable disc and
6 positioned between the first and second protrusions.

1 10. The micropump of claim 2, further comprising at least one electrostatic comb
2 drive for rotating the at least one rotatable disc.

1 11. The micropump of claim 10, further comprising at least one gear in contact
2 with the electrostatic comb drive and in contact with the at least one rotatable disc.

1 12. The micropump of claim 11, wherein the at least one gear comprises a 12:1
2 torque amplification gear train.

1 13. The micropump of claim 1, wherein said pumping chamber includes at least
2 two rotatable gears therein, said structure for mechanically urging comprising said rotating
3 gears.)

1 14. The micropump of claim 13, wherein the at least two rotatable gears comprises
2 at least three rotatable gears, wherein a first rotatable gear is rotatably attached to a pin
3 substantially at a center point of the base layer and includes a plurality of gear teeth, a second
4 rotatable gear including a plurality of teeth on a side surface is positioned between the first
5 rotatable disc and a side wall of the monolithic body, and a third rotatable gear including a
6 plurality of teeth on a side surface and having a diameter larger than the second rotatable
7 gear is positioned between the first rotatable gear and a side wall of the monolithic body.

1 15. A micropump, comprising:
2 a monolithic body formed from between about two layers of silicon and about five
3 layers of silicon and having a thickness no more than about 12 microns, wherein the
4 monolithic body comprises a base layer and side walls forming an pumping chamber

5 containing at least one rotatable disc; wherein said pumping chamber includes an inlet for
6 drawing fluid therein and an outlet for expelling said fluid out of said cavity; and
7 at least one rotatable disc positioned in the pumping chamber for drawing a fluid
8 through the inlet and expelling the fluid out of the outlet.

1 16. The micropump of claim 15, wherein the at least one rotatable disc comprises
2 at least one protrusion extending from the disc.

1 17. The micropump of claim 15, wherein the at least one protrusion forms a spiral
2 shaped fluid pathway concentric with the at least one rotatable disc.

1 18. The micropump of claim 15, wherein the at least one protrusion forms a
2 plurality of radial vanes extending from an axis of rotation of the rotatable disc.

1 19. The micropump of claim 15, wherein at least one rotatable disc further
2 comprises a plurality of gear teeth on a side surface of the rotatable disc.

1 20. The micropump of claim 19, further comprising at least one crescent shaped
2 diverter positioned in the pumping chamber proximate to the at least one rotatable disc, and
3 wherein an inner surface of the monolithic body includes a plurality of gear teeth for
4 meshing with the at least one rotatable disc.

1 21. The micropump of claim 15, wherein the at least one rotatable disc comprises
2 at least three rotatable discs, wherein a first rotatable disc is rotatably attached to a pin
3 substantially at a center point of the base layer and includes a plurality of gear teeth, a second
4 rotatable disc including a plurality of teeth on a side surface is positioned between the first
5 rotatable disc and a side wall of the monolithic body, and a third rotatable disc including a
6 plurality of teeth on a side surface and having a diameter larger than the second rotatable disc
7 is positioned between the first rotatable disc and a side wall of the monolithic body.

1 22. The micropump of claim 15, further comprising at least one cap forming a
2 portion of the monolithic body and having an opening enabling a driving gear to contact the
3 at least one rotatable disc contained in the monolithic body.

1 23. The micropump of claim 15, further comprising a labyrinth seal formed from a
2 first protrusion forming a ring extending generally vertically from the base layer and
3 surrounding the rotatable disc, a second protrusion forming a ring extending generally
4 vertically from the base layer and positioned inside the first protrusion, and a third protrusion
5 forming a ring extending generally vertically from the at least one rotatable disc and
6 positioned between the first and second protrusions.

1 24. The micropump of claim 15, further comprising at least one electrostatic comb
2 drive for rotating the at least one rotatable disc.

1 25. The micropump of claim 24, further comprising at least one gear in contact
2 with the electrostatic comb drive and in contact with the at least one rotatable disc.

1 26. The micropump of claim 25, wherein the at least one gear has a 12:1 torque
2 amplification gear train.

1 27. A method of pumping fluids, comprising:
2 rotating at least one rotatable disc positioned in a pumping chamber of a miropump
3 formed from a monolithic body having a thickness no more than about 12 microns and
4 containing the at least one rotatable disc; wherein a fluid is drawn through an inlet in the
5 pumping chamber and expelled from an outlet in the pumping chamber.

1 28. The method of claim 27, wherein rotating at least one rotatable disc comprises
2 rotating at least one disc comprising at least one protrusion extending from the disc.

1 29. The method of claim 28, wherein rotating at least one rotatable disc having at
2 least one protrusion extending from the disc comprises rotating at least one disc having a
3 spiral shaped protrusion extending from the disc.

1 30. The method of claim 28, wherein rotating at least one rotatable disc having at
2 least one protrusion extending from the disc comprises rotating at least one disc having a
3 spiral shaped protrusion extending from the disc.

1 31. The method of claim 27, wherein rotating at least one rotatable disc is
2 accomplished using at least one electrostatic comb drive.

1 32. The method of claim 27, wherein rotating at least one rotatable disc drives at
2 least one idler gear positioned in the pumping chamber of the at least one rotatable disc.

1 33. The method of claim 27, wherein rotating the at least one rotatable disc
2 comprises rotating at least three gears in the pumping chamber.